An Analysis of the Sources of Profit Volatility in Cattle Feeding

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Cattle feeding is typically viewed as "risky business". This view is primarily based upon observation of the volatility of fat cattle, feeder cattle and grain prices. Very little comprehensive data has been assembled to study the actual degree and nature of the volatility present in cattle feeding profits at the individual pen level. This study analyzes the degree and nature of cattle feeding profit volatility at the pen level by using data for four hundred eighty pens of cattle marketed over a twelve month period. For each of these pens of cattle complete "close-out sheet" data sets were available which described the costs, revenues and physical performances of the pens. By using this data the study reported here was able to separate and quantify the causes of profit volatility in cattle feeding into three categories; market risk due to price volatility; production risk due to physical performance volatility; and financial risk due to interest rate volatility and leveraging. Furthermore the interrelations between the sources of volatility in cattle feeding were modelled and analyzed. The results of the study indicate that the use of aggregated data and average values together with the assumption of independence between multiple sources of random variation leading to profit volatility may cause misleading conclusions. Thus this study raises several questions about the validity of a number of past research results and common management practices dealing with risk analysis and decision making in cattle feeding.

DATA CONSIDERATIONS AND TRADITIONAL ANALYSIS APPROACHES

Data were obtained from four feedlots over the period May 1986 through April 1987. The data were not obtained directly from the feedlots but through a consulting company (Professional Cattle Consultants Inc.) serving these feedlots and over one hundred additional feedlots. One advantage of obtaining the data through the consulting company was that a standardized reporting systems was used. Data on ten pens of cattle were obtained from each feedlot each month making a total of forty observations per month and four hundred eighty observations over the entire data period. In a few cases when one of the feedlots did not market ten pens of cattle in a single month, additional observations were obtained from one of the other three feedlots.

The data contained the following specific information for each pen of cattle: the placement date, the average placement weight, the number of head placed, and the average price paid per pound; the date the pen was sent for slaughter, the average slaughter weight, the number of head slaughtered, and the average slaughter price received; the total pounds gained; the total days on feed; the

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total pounds of feed consumed; the total cost of feed; the feed conversion rate; the percent of dry matter of the feed; feedlot service charges; the interest charge on the cattle; the interest charge on the feed; and the net return per head. The data was such that various consistency checks could be run to check its accuracy and additional variables such as cost of feed per pound could be derived.

The typical/traditional approach to using the above described data to analyze feedlot profits is the closeout sheet or budgeting approach. This process is illustrated in Table 1. The United States Department of Agriculture (USDA) follows a procedure similar to that shown in Table 1 to budget and report estimates of High Plains and Corn Belt cattle feeding profits on a monthly basis. They use average aggregate prices for the region in question, coupled with "typical" physical parameters. The average price values used by the USDA are changed monthly, but the physical parameters are not changed.

Table 1. Closeout Sheet/Budget Example.

REVENUE	
(SLAUGHTER WT. * SLAUGHTER PRICE) * (1 - DEATH%)	
(1145 * .60) * (1 - .007)	$682.19/hd
FEEDER COST	
(PLACEMENT WT. * FEEDER PRICE)	
(739 * .59)	$436.01/hd
COST OF GAIN[1]	
(FEED PRICE * POUNDS OF FEED FED)	
(.05 * 3520)	$176.00/hd
INTEREST ON CATTLE	
(FEEDER COST * INTEREST RATE * DAYS ON FEED/365 * % FINANCED)	
(436 * .11 * 164/365 * .75)	$ 16.16/hd
INTEREST ON FEED	
(FEED COST * INTEREST RATE * DAYS ON FEED/365 * % FINANCED)	
(176 * .11 * 164/365 * .35)	$ 3.04/hd
NET RETURN PER HEAD	
(REVENUE - FEEDER COST - COST OF GAIN - INTEREST ON CATTLE - INTEREST ON FEED)	
($682.19 - $436.01 - $176.00 - $16.16 - $3.04)	$ 50.98/hd

[1] Pounds of feed are determined from pounds of gain (slaughter weight minus placement weight) and the feed conversion rate which indicates the pounds of feed required to produce one pound of gain. Feedlot service charges are incorporated into the feed price through a feed price markup charge.

Table 2. Estimated mean, variance, and standard deviation of individual pen data variables

VARIABLE	MEAN	VARIANCE	STANDARD DEVIATION
Feeder Price ($/lb)	$0.59	.00268	$0.0517
Slaughter Weight (lbs)	1146.15	6531.501	80.8177
Conversion Rate (lbs feed/lb of Gain)	8.2957	0.5815	0.7625
Days on Feed (days)	137.68	1794.52	42.3617
Slaughter Price ($/lb)	$0.6043	0.00158	$0.03982
Feed Price ($/lb)	$0.0511	0.000011	$0.00345
Placement Weight (lbs)	728.578	11091.358	105.3155
Interest Rate (%)	0.1202	0.000018	$0.00427
Average Industry Feed Price ($/lb)	$0.0669	0.000015	$0.00387
Pounds of Gain (lbs)	419.4474	4163.6836	64.5266
Average Daily Gain (lbs)	3.2073	0.2650	0.51479
Pounds of Feed (lbs)	3397.3044	200473.284	447.7423
Death Loss Percentage (%)	.006920	.00116	.010791
Revenue ($/hd)	$685.558	4112.4701	$64.1285
Feeder Cost ($/hd)	$434.2895	3649.2758	$60.4092
Feed Cost ($/hd)	$175.3796	645.5927	$25.4085
Interest on Cattle ($/hd)	$16.4559	17.9341	$4.2348
Interest on Feed ($/hd)	$3.3504	1.7890	$1.3375
Net Return ($/hd)	$56.3189	2798.6474	$52.9022

To consider riskiness in cattle feeding, the traditional approach has been to determine the mean and variance of each of the basic variables used in the budgeting process and then use stochastic simulation to generate a set of random net profits. More specifically, the budgeting process reported in Table 1 contains eleven fundamental variables; a) slaughter weight; b) slaughter price; c) placement weight; d) feeder price; e) feed price; f) feed conversion rate (which together with pounds gained as determined from slaughter weight minus placement weight can be used to determine total pounds of feed fed), g) interest rate; h) days on feed; i) percent of the feeder cattle cost financed; j) percent of the feeding cost financed; and k) the death loss rate. To determine the mean and variance of profit, each of the eleven variables is randomly generated based upon its mean and variance values. Then the budgeting calculations depicted in Table 1 are undertaken to determine the resulting profit. By repeating this process numerous times an estimate of expected profit and profit variance can be made. It is especially critical to note at this point that the traditional stochastic simulation process as described and conducted here assumes each of the stochastically generated random variables to be independent, and normally distributed.

Table 2 reports the mean, variances and standard deviations of the data collected. Thus it provides the basic data needed to stochastically simulate profit by the traditional procedure described above. One exception is that the percent of feeder cattle cost and feeding cost financed is not reported in the data set. Hence these two values must be set at arbitrary constants. In this study they were set at .75 and .35 respectively for percent of feeder cattle cost financed and percent of feeding cost financed.

In addition to reporting the means, variances and standard deviations for the basic component variables of the budget, Table 2 also reports the means, variances and standard deviations of several aggregations of the basic variables, including total revenue, feeder cost, feed cost and net returns. These aggregated values were not generated by simulation, rather they were taken directly from the reported data set. Thus they can be used to provide a check upon the accuracy of the stochastic simulation in recreating the aggregate data.

The average profit per head reported in Table 2 is $56.32. This is a relatively high figure and reflects the fact that the data period used was a favorable period for cattle feeding with regard to profit levels. The reported standard deviation on this profit is $52.90. Thus despite the high level of profits reported, the high standard deviation level relative to the profit level confirms the riskiness generally associated with the cattle feeding industry.

If the values reported in Table 2 are used to stochastically simulate the budget depicted in Table 1, the results under estimate the data sample mean by approximately 5 percent. Since all distributions are assumed to be independent and normally distributed the expected mean from this simulation process is the same as the budgeted results using the mean of each variable, thus it can be shown that using the mean values reported in Table 2 in the budget results in an under estimate of the reported mean by approximately 5 percent. The estimated variance obtained from the simulation process, assuming independence among the budget variables, over estimates the data sample variance by about 50 percent.

It is hypothesized from the results presented thus far, and results yet to be presented, that the reason the stochastic simulation process under estimates the data mean and over estimates the data variance is because of the assumed independence between the budget variables. It is hypothesized that rather strong correlation exists between many of the variables in the budget. For example, placement weights are strongly correlated with feeder cattle prices, i.e. lighter feeder cattle are generally higher priced. Likewise placement weight is related to feed conversion efficiency, days on feed, and slaughter weight. Slaughter weight and slaughter price are correlated. The reasons for these correlations are inherent in the physical nature of cattle feeding and the characteristics of the cattle market. The market generally prices heavy slaughter cattle at a discount due to quality deterioration as cattle are "over fed". Likewise the market price is generally higher for lighter weight feeder cattle due to their superior feed converting ability. Management's responses to economic conditions also causes correlations to exist between variables contained in the budgeting process. For example, if feed costs are high the feeding period will be shortened by slaughtering at lighter weights and placing at heavier weights. Also management can generally recognize lower quality cattle prone to higher death loss rates or less desirable feed conversion rates. Lower quality cattle will generally be purchased and fed only at lower prices. These and other management actions cause physical performance variables to be correlated to prices and market conditions. Budgeting and modelling processes which ignore correlations between the budget variables due to market and management factors, particularly those correlations due to management action, will tend to under estimate the profitability of cattle feeding.

If the above hypothesis is correct, it suggests corrective action can be taken in the stochastic simulation model by recognizing the interrelations referred to above and quantifying them into the simulation model's structure. Likewise the hypothesis implies that the budgeting and traditional stochastic simulation approaches to analyzing cattle feeding decisions and risk levels should be used with some caution. Traditional budgeting approaches that use expected values for each budget variable can be expected to under estimate actual average profit to some degree. Furthermore, stochastic simulation analyses that assume independence among budget variables may overestimate the degree of volatility present in cattle feeding. These generalizations may well apply to commodities other than fed cattle. The extent to which these generalizations apply to other commodities can not be determined without good micro level data for the commodities in question. However it is hypothesized that these generalized cautions would most likely apply to those commodities for which management has a large degree of control and for which the market price varies sharply with changes in physical properties of the commodity.

MODELLING BUDGET COMPONENT INTERACTION

Much of the interaction between the basic component variables in the cattle feeding budget is systematic and explainable. Thus it can be modelled/estimated using regression analysis. Any unexplained stochasticness left after modelling the structural interrelations between the component variables in the cattle feeding budget can then be modelled using stochastic simulation. The stochastic simulation of this remaining volatility can also be designed to consider any remaining covariance between the randomness remaining unexplained for each budget variable.

A five equation model was developed to explain the structure of the relationships between the basic variables in the cattle feeding budget. The five equations estimated are reported in Table 3. Values reported under the parameters are the t-values for the associated parameter. Eleven dummy variables were attached to each equation to account for seasonal variation in each equation's relationship.

Equation #1 indicated feeder cattle price has a quadratic relationship with placement weight. Equation #2 indicates slaughter weight is significantly related to placement weight and animal quality. Animal quality is proxied by the difference between the actual average feeder cattle price paid for the pen of cattle in question, and Equation #1's estimate of the average price paid in general for cattle of the same weight. Alternatively stated, the cattle quality proxy variable is the error term of Equation #1 in predicting the average feeder cattle price for the pen in question. A positive error term for the feeder cattle price equation is assumed to indicate the pen of cattle in question is of superior quality, and vice versa in the case of a negative error term. Equation #3 indicates the feed conversion rate is related to the placement weight, slaughter weight, and animal quality. Equation #4 indicates slaughter price is related to slaughter weight and animal quality. Equation #5 indicates that the number of days on feed variable is related to placement weight, slaughter weight, and the feed conversion rate.

Ignoring the dummy variables, all variables included in the five structural equations were found to be significant at the .01 level of significance except the placement weight squared variable in the feeder cattle price equation. It was significant at the .05 level of significance.

These five equations were used to model the interaction between five of the nine basic budget variables, where the basic stochastic budget variables are taken to be slaughter weight, slaughter price, placement weight, feeder cattle price, feed price, feed conversion rate, days on feed, death loss, and interest rates. Placement weight is specified as an independent random exogenous variable to the five equations. Likewise feed price, death loss, and interest rates are considered to be random independent variables. Efforts to estimate relationships between death loss rates and variables such as animal quality and placement weight found no significant relations.

To inject stochasticness into the system, the random error associated with each equation was added to the solution for each equation as the model was simulated. Randomness was also added to the four independent variables, i.e. placement weight, feed price, death loss rate, and interest rates. Additionally the time variable injected into the dummy variable set was randomly drawn from a uniform distribution.

Rather than assuming the randomness being simulated for each of the five equations and four exogenous variables was independent, the covariance matrix between these nine error variables was calculated from the raw data. Following a procedure developed by Naylor, these nine random variables were modelled as correlated random variables. In actuality the degree of correlation

Table 3. Structural Equations of the Cattle Feeding Budget Model

Variables	#1 Feeder Price ($/lb)	#2 Slg. Wt. (lbs)	Equation #3 Feed Conversion Rate (lbs feed/lbs gain)	#4 Slg. Price ($/lb)	#5 Days on Feed
Constant Term	.8827	728.4	8.925	.6286	164.66
Placement Wt. (lbs)	-.0004	.5718	.0065	-----	-.3873
	(3.1)	(24.9)	(17.0)	-----	(14.1)
Placement Wt. Squared	.0000002	-----	-----	-----	-----
	(2.0)				
Feeder Cattle Quality Proxy[1]	-----	27.82	-3.089	.4155	-----
		(2.4)	(4.3)	(17.3)	
Slaughter Wt. (lbs)	-----	-----	.0048	-.00003	-.1710
			(9.4)	(2.8)	(5.4)
Conversion Rate (lbs feed/lb gain)	-----	-----	-----	-----	6.423
					(2.5)
February Dummy	-.0043	-19.33	.2116	.0267	2.152
	(0.5)	(1.7)	(1.7)	(6.5)	(0.3)
March Dummy	-.0279	-11.08	.4749	.0423	9.251
	(3.1)	(1.0)	(3.9)	(10.3)	(1.3)
April Dummy	-.0663	-23.87	.9198	.0828	8.141
	(6.5)	(2.1)	(7.5)	(20.1)	(1.1)
May Dummy	-.0785	13.36	.1318	-.0223	7.278
	(8.5)	(1.2)	(1.07)	(5.5)	(1.0)
June Dummy	-.0658	-5.41	.1389	-.0290	7.428
	(6.5)	(0.5)	(1.1)	(11.9)	(1.1)
July Dummy	-.0155	11.72	-.0242	-.0140	8.093
	(1.7)	(1.0)	(0.2)	(3.4)	(1.2)
August Dummy	.0146	15.93	-.0607	-.0033	8.894
	(1.6)	(1.4)	(0.5)	(0.8)	(1.3)
September Dummy	.0154	11.46	-.1372	.0088	12.03
	(1.7)	(1.0)	(1.1)	(2.1)	(1.7)
October Dummy	.0009	6.49	-.1994	.0146	4.134
	(0.1)	(0.6)	(1.6)	(3.5)	(0.5)
November Dummy	.0089	13.07	.0067	.0257	.1698
	(1.0)	(1.2)	(0.1)	(6.2)	(0.2)
December Dummy	.0015	2.07	-.1256	.0244	1.890
	(0.2)	(0.2)	(1.0)	(5.8)	(0.3)
R-Square	.54	.63	.50	.79	.48
Standard Error of the Estimate	.0357	49.86	.5476	.0184	30.94

[1] The quality proxy variable used was the error term on the feeder cattle price prediction equation.

existing between these nine random variables was quite low. Never-the-less it was considered and does influence the stochastic simulation results slightly.

Using the above modelling approach, the mean value and variance of the collected data set were accurately reproduced using stochastic simulation. Table 4 and 5 report the simulated versus actual mean and variances where the simulated mean and variance estimates are based upon one hundred stochastic simulation runs. All variances reported in the table were found to be statistically identical at the .05 level of confidence or higher, except for average daily gain. The variance of net return was accepted as equal to that of the data set at the .01 level of significance. All of the simulated mean values were accepted as equal to the data set means at the .05 level of significance or higher.

ANALYZING THE NATURE AND SOURCE OF FEEDLOT PROFIT VOLATILITY

The model described in the preceding section was used to analyze the sources and nature of profit volatility in cattle feeding. Given the model's accurate representation of the variations in cattle feeding profit, isolating the sources of profit volatility in cattle feeding might appear to be a straight forward task of sensitivity testing. At first consideration one would think you could replace each random budget variable with its' mean value, resimulate the model, and compare the new profit variance estimate to the original base model estimate. This approach is not as valid as it may seem due to the structural interaction of the variables in question. An example will suffice to illustrate the point and raise some relevant issues with regard to past analyses of risk management using hedging.

If one desires to know the impact of slaughter price volatility on cattle feeding profit volatility they might choose to remove the slaughter price equation from the model and replace its solution value with the mean slaughter price in each stochastic simulation run. This would appear to be in violation of the basic logic of the model's structure. To hold slaughter price constant while allowing feeder quality, time, and slaughter weight to vary is inconsistent with the estimated structure of the model. What is consistent is the fact that slaughter price volatility, as modelled and perceived in reality, is caused by a number of factors. To honor the model's structure while totally stabilizing slaughter price would require stabilizing all the factors contributing to slaughter price volatility, i.e. slaughter weight, animal quality, and time are stochastic variables in the slaughter price equation. However, these contributing factors are also interrelated with other factors. For example, to stabilize the slaughter weight would necessitate stablizing the variables in the slaughter weight equation. In essence the model structure is such that all sources of volatility must be stabilized in order to totally stabilize any given variable. Thus, the interrelatedness of the sources of volatility leads to the fact that one can not legitimately "totally" separate independent sources of variation in cattle feeding profits.

Table 4. Variance Comparisons used for Model Validation

VARIABLE	PEN DATA	MODEL ESTIMATES
Feeder Price ($/lb)	0.002681	0.002497
Slaughter Weight (lbs)	6531.501	6398.987
Conversion Rate (lbs feed/lb of Gain)	0.581513	0.619132
Days on Feed (days)	1794.521	1670.372
Slaughter Price ($/lb)	0.001585	0.001099
Feed Price ($/lb)	0.000011	0.000011
Placement Weight (lbs)	11091.35	11459.19
Interest Rate (%)	0.000018	0.000018
Average Industry Feed Price ($/lb)	0.000015	0.000014
Pounds of Gain (lbs)	4163.683	4881.788
Average Daily Gain (lbs)	0.265018	1.051788
Pounds of Feed (lbs)	200473.2	189637.6
Death Loss Percentage (%)	0.000116	0.000159
Revenue ($/hd)	4112.47	2998.177
Feeder Cost ($/hd)	3649.275	4031.962
Feed Cost ($/hd)	645.5927	612.6995
Interest on Cattle ($/hd)	17.93413	18.45022
Interest on Feed ($/hd)	1.789087	1.577522
Net Return ($/hd)	2798.647	4624.645

Table 5. Mean Comparisons used for Model Validation

VARIABLE	PEN DATA	MODEL ESTIMATES
Feeder Price ($/lb)	$0.5991	$0.595709
Slaughter Weight (lbs)	1146.15	1147.035
Conversion Rate (lbs feed /lb of Gain)	8.2957	8.230116
Days on Feed (days)	137.6815	136.4905
Slaughter Price ($/lb)	$0.6043	$0.6024
Feed Price ($/lb)	$0.051123	$0.051382
Placement Weight (lbs)	728.578	729.1675
Interest Rate (%)	0.1202	0.12033
Average Industry Feed Price ($/lb)	$0.0669	$0.670
Pounds of Gain (lbs)	419.4474	417.8684
Average Daily Gain (lbs)	3.2073	3.3003
Pounds of Feed (lbs)	3397.304	3402.557
Death Loss Percentage (%)	0.0069204	0.007464
Revenue ($/hd)	$685.4531	$685.2446
Feeder Cost ($/hd)	$434.2895	$432.7271
Feed Cost ($/hd)	$175.3796	$174.7828
Interest on Cattle ($/hd)	$16.45595	$16.1742
Interest on Feed ($/hd)	$3.350453	$3.21691
Net Return ($/hd)	$56.3189	$58.3434

Given the complexity of the sources of stochastic variation in cattle feeding profits described above, two approaches were taken to identifying the sources of cattle feeding profit variation. The first was to violate the logic of the model and hold individual budget variables constant. The second was to remove only the random error term from each of the five model equations and allow all other interaction between the variable in question and the rest of the model to continue. This results in the variable in question continuing to contain variance due to its' interaction with other variables. But it also reduces the volatility of the variable in question, and in turn its' impact upon the volatility of the other variable, by the amount of the error term of the variable equation in question.

Table 6 reports the results of the first approach where selected variables and sets of variables were held constant. The standard deviation of net returns in the original model was $68.00. The standard deviations of net returns reported in Table 6 are those obtained with the indicated variable(s) held constant. The variables are listed according to the amount of variance reduction achieved. Perhaps not surprisingly, slaughter price ranks first. It is followed by feeder price, placement time, feeder quality, feed price, etc. Slaughter weight and interest rates rank at the bottom of the list. In fact stabilizing interest rates leads to a slight increase in profit volatility. This is speculated to be the case because of the covariance structure between interest rates and other variables in the model and its apparent stabilizing relationships due to negative correlation. Whether interest rate volatility increases or decreases profit volatility appears to be a mute question since the degree of change in profit variance due to interest rate volatility, as well as slaughter weight volatility, is so small it is virtually insignificant.

The last two values reported in Table 6 show the affect upon profit volatility of stabilizing two sets of variables. The first set of variables contains all the market prices in the budget and reflects "market risk" factors. The second set contains all the the physical parameters in the budget and reflects "production risk". As can be seen in the Table, the reduction in profit volatility due to removing market risk is nearly three times more than that due to removing production risk, i.e. 65.5 percent versus 22.05 percent. This result appears to be quite consistent with the greater concern most cattle feeders have about market risk versus production risk.

Table 7 reports the results of the second approach to analyzing the sources of profit volatility. In this approach only the random error term associated with each structural equation in the stochastic budget model was held constant, i.e. in this case set equal to zero. The volatility of the variable in question was thus reduced, but it continued to be volatile due to the volatility of variables within the equation used to calculate its value. The results produced are quiet different than with the first approach and provide several insights.

The most significant difference between the results from this approach and the first approach is that the amount of profit variation reduction is greatly reduced. Also, the ranking of the variables with regard to the amount of profit variation reduction is quiet different. In fact the only variable now shown to have much of an impact on profit volatility is feeder cattle price. Setting the error term of the feeder cattle price equation to zero results in a 17.7 percent reduction in profit variation.

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Table 6. Simulated Changes in Net Return Variance with Selected Variables Held Constant

STABILIZED VARIABLE	NET RETURNS STANDARD DEVIATION ($/hd)	PERCENT OF TOTAL DEVIATION[1] (%)
Slaughter Price	$45.98	67.67
Feeder Price	$48.83	71.80
Month (Time)	$52.47	77.15
Feeder Quality	$58.27	85.68
Feed Price	$63.76	93.75
Death Loss Percentage	$66.86	98.31
Conversion Rate	$66.88	98.34
Placement Weight	$67.08	98.64
Days on Feed	$67.87	99.80
Slaughter Weight	$67.74	99.61
Interest Rate	$68.42	100.60
Price (Feeder Price, Slaughter Price, and Feed Price)	$23.42	34.44
Physical (Feeder Quality, Death Loss Percentage, Conversion Rate Placement Weight, Days on Feed, and Slaughter Weight)	$53.01	77.95

[1]Calculated by taking the deviation in net returns in Column 1 and dividing by the deviation in net returns reported in Table 4 (68.004), which was calculated with all sources of randomness active.

Table 7. Simulated Changes in Net Return Variable with Selected Error Terms Held Constant

VARIABLE	NET RETURN STANDARD DEVIATION ($/hd)	PERCENT OF TOTAL DEVIATION[1] (%)
Slaughter Weight	$67.52	99.28
Conversion Rate	$69.14	101.67
Days on Feed	$67.94	99.90
Feeder Price	$55.98	82.31
Slaughter Price	$64.93	95.47

[1]Calculated by taking the deviation in net returns in Column 1 and dividing by the deviation in net return in Table 4 (68.004), which was calculated with all sources of randomness active.

Surprisingly, setting the error term of the slaughter price equation to zero results in less than a 5 percent reduction in profit variation. This raises a rather pertinent question. Does this imply hedging slaughter price has little influence upon cattle feeding profit volatility? Further research is likely needed to answer this question authoritatively, but the implication is that slaughter price hedging may not be a very effective risk reducing tool. As seen in Table 6, slaughter price variation in total is a significant cause of profit volatility. But when the variation in slaughter price due to slaughter weight, animal quality, and time are allowed to continue, very little reduction in profit volatility occurs when the slaughter price equation error term is set to zero. It is presumably this part of slaughter price volatility, as reflected by the slaughter price error term, that hedging deals with. Slaughter price volatility due to slaughter weight and animal quality are presumably much of what causes individual pen basis risk, and can not be eliminated by hedging. These results may explain why many producers have not readily adopted slaughter price hedging as a risk management tool.

CONTROLLING THE RISK OF LOSS

The larger the volatility of profits, the larger is the probability that an individual pen of cattle will have a loss. Also the lower the expected net return, the greater the probability of loss on an individual pen of cattle, given the same degree of volatility. Thus reducing profit volatility or raising the expected profit level can reduce the probability of loss or risk on a given pen of cattle. Both of these approaches to reducing the risk of suffering a loss will be briefly investigated here using the stochastic model developed in this study.

In the preceding section of this analysis, hedging feeder cattle prices was found to be the most effective single action one could take to reduce profit volatility, i.e. removal of the error term on the feeder cattle structural equation resulted in a 17.7 percent reduction in profit volatility. By reducing the variance of the error term for the feeder cattle price equation by 0, 20, 40, 60, 80 and 100 percent, the corresponding levels of hedging of feeder cattle prices was assumed to be simulated. The results of such hedging upon the probability of suffering a loss on a given pen of cattle are reported in Table 8.

As seen in Table 8, with no hedging the probability of a loss is 20 percent. This probability is relatively low given the high level of profit being enjoyed during the data period used. However it is still significant because of the large variance in feeding profits. However, as hedging is increased and the profit variance reduced, the probability of loss declines to 15 percent. It is felt that this type of reduction in the probability of a loss will also be achieved when profits are at a lower level. Indeed the reduction in the probability of a loss may be even greater when profit levels are lower.

Table 8. Effects of Hedging Strategies of Feeder Cattle Prices on Net Return Mean and Variance Estimates

		----NET RETURN/HD----	
% HEDGED	PROBABILITY OF LOSS	MEAN	STD DEV
0	20%	$58.34	$68.00
20	19%	$58.06	$64.82
40	19%	$57.76	$62.01
60	19%	$57.45	$59.56
80	17%	$57.15	$57.54
100	15%	$56.85	$55.98

Table 9 reports the effect of increasing the expected profit level of cattle feeding by increasing the level of equity in the cattle and feed used and thus reducing the direct interest expense. Likewise the table reports the effect of financial "leveraging" upon the probability of suffering a loss on a given pen of cattle. The probability of a loss on a given pen of cattle declines from 22 percent with zero equity, to 14 percent with 100 percent equity. This is due primarily to the expected profit raising from $50.78 to $77.73. This implies the average cost of financing an animal on feed during the period in question was $26.95. As Table 9 reflects, profit volatility is not greatly reduced by increasing equity, thus the reduction in the probability of a loss is mostly due to the increased expected profit level.

It should be noted that this particular example of the effect of increasing the profitability of cattle feeding does not consider the opportunity cost of capital. Raising or lowering the mean value of slaughter price or feeder cattle price would be a cleaner example of the effect of increased or decreased profit levels upon the probability of suffering a loss. Such an example would not simultaneously address the related issue of financial leveraging.

Table 9. Effects of Alternative Equity Levels on Net Return Mean and Variance Estimates

% HEDGED	PROBABILITY OF LOSS	----NET RETURN/HD---- MEAN	STD DEV
0%	22%	$50.78	$68.05
20%	21%	$56.08	$68.00
30%	19%	$59.91	$66.22
40%	17%	$61.49	$67.75
60%	16%	$66.91	$67.52
80%	14%	$72.32	$67.34
100%	14%	$77.73	$67.19

SUMMARY AND IMPLICATIONS

Previous studies of cattle feeding risk have focused on the use of the futures market and have based their analysis on aggregate data. This study used pen level data and focused upon identifying the structure of the price and production risk associated with cattle feeding. The study concludes that the factors causing volatility in cattle feeding profits have a complex and highly interlinked structure.

Many past studies of risk have casually assumed that the factors (prices, quantities, and technical coefficients) causing profit volatility are random and independent. As stated above, in the case of cattle feeding the factors leading to profit volatility were found to be highly interdependent. To ignore this interdependence leads to an under estimate of the expected profit level and an overestimate of the expected volatility/risk level.

Results of the study indicate that market risk due to price volatility has approximately three times the impact upon cattle feeding profit volatility that production risk has. More detailed analysis indicated that feeder cattle price hedging is likely to be of more benefit in reducing profit volatility and the risk of suffering a loss than is slaughter price hedging. Additional analysis indicated that financial leveraging can nearly double the probability of encountering a loss on a given pen of cattle.

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